TECHNICAL MEMORANDUM

Summary of Sources at the P4 Soda Springs Plant, Soda Springs, Idaho

PREPARED FOR:	Lynne Hood/USEPA
COPY TO:	File
PREPARED BY:	CH2M Technical Team
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This Technical Memorandum provides overview of the environmental issues at the P4 Soda Springs Plant in Soda Springs, Idaho (Site).

History of the Environmental Investigations and Remediation

The key events in the investigation and remediation of environmental issues at the Site are summarized below.

1952	Elemental phosphorus production started at the site by Monsanto on former agricultural and domestic property.
1980s	Landowner immediately south of former plant boundary identified groundwater impacts. Monsanto purchased land immediately south of former plant boundary. Suspected source areas were closed and capped including: • Removal of the Old Hydroclarifier • Decommissioning old Underflow Solids (UFS) Ponds and Tailings Ponds • Filling with molten slag and sealing with a bentonite cap closing • Excavating, and sealing the Northwest Pond
1984	Initial Site Characterization by Golder.
1990	EPA placed the site on National Priorities List (NPL) on August 30.
1991	**Administrative Order of Consent** (AOC) for a Remedial Investigation and Feasibility Study (RI/FS) agreed to on March 19.
1991-1995	**RI/FS** showed groundwater under the Site contained elevated levels of fluoride, cadmium, selenium, nitrate, and manganese.
1997	**Record of Decision** (ROD) of April 30, **Remedial Action Objectives** (RAOs) were: • The ultimate goal is to ensure that groundwater contamination sources have been eliminated and that **natural attenuation will eventually (within 5 to 30 years)** restore the groundwater aquifers affected by past releases from Site. • Prevent human ingestion of, inhalation of, or direct contact with groundwater at levels exceeding the maximum contaminant levels (MCLs) for cadmium, fluoride, manganese, nitrate, and selenium. • Prevent external exposure to radionuclides in soils at levels that pose cumulative estimated risks above 3×10^{-4}, corresponding to a dose equivalent of approximately 15 millirems per year.

- Prevent the ingestion or inhalation of soils containing radionuclides at levels posing cumulative estimated risks exceeding 3 x 10^{-4}, or metals (arsenic, beryllium) at levels posing cumulative estimated carcinogenic risks exceeding 1x10^{-5}.

Selected remedies of the 1997 ROD are:

- Monitored Natural Attenuation (MNA) with Institutional Controls (ICs) for contaminated groundwater.
- Either ICs or soil excavation on buffer properties not owned or controlled by Monsanto, at the discretion of the owner, for contaminated soils.
- No Further Action (NFA) for operating area source piles and materials, subject to continued operations and ongoing Five-Year Reviews.
- NFA for air, surface water, and sediments in Soda Creek.

The contaminants of concern (COCs) identified in the 1997 ROD included:

- Radium-226 in soil, and
- Fluoride, cadmium, manganese, nitrate, and selenium in groundwater.

1998	P4 Productions, LLC, was formed by Monsanto to own and operate Monsanto's elemental phosphorus plant at this location after Monsanto entered into the June 1998 **Consent Decree** with the United States to implement the ROD.
1998 on	Wells and springs sampled annually to present.
2003	First Five-Year Review.
2007	Four additional groundwater wells installed.
2008	Second Five-Year Review.
2011	Eight additional monitoring wells installed.
2012	Soil and Sediment Multi-Increment Sampling.
2013	Third Five-Year Review.
2012-2015	Source Area Characterization to evaluate if historic sources still remain and if these sources are contributing to groundwater loading.
2017	Pumping wells installed at the south fence line to intercept and treat the impacted groundwater.
2018	Fourth Five-Year Review.

Site Description

Basic features of the Site and surroundings are provided below.

- The Site is located in Caribou County, approximately 1 mile north of the city of Soda Springs. Soda Springs has a population of 3,058 (U.S. Census Bureau 2013 http://www.census.gov/).
- Significant groundwater resources lie underneath the broad valley where both the Site and the city of Soda Springs are located. Groundwater extracted by four onsite production wells provides the process water for operations at the Site. Groundwater is also the main source of drinking water for the area, with Foundation Spring and Lower Ledger Spring serving as the sources of drinking water for the City of Soda Springs. Foundation Spring is located northeast of the Site and Upper and Lower Ledger Springs are located to the south of the Site. Groundwater beneath the Site generally flows southward toward Soda Springs.

- The Site is 800 total acres that include the 540-acre operating area and an additional approximately 260 acres of buffer area—owned in partly by the Site owners and partly by various farmers.
- The Site lies in a valley at approximately 6000 feet above mean sea level in elevation, within a tributary valley to the Bear River that is drained by Soda Creek.
- The Site has very complex hydrogeology with four upper basalt zone (UBZs), one Lower Basalt Zone (LBZ), multiple faults that can acts as barriers or preferential pathways, varying vertical gradients, basal upwelling, significant pumping of groundwater for ongoing operations of the facility.
- Across State Route 34 to the east of the Site, Kerr- McGee formerly owned and operated a vanadium production facility beginning in 1964. The Kerr-McGee site was placed on the NPL on October 4, 1989. Groundwater contamination from the Kerr-McGee site (specifically molybdenum) extends onto the southeast portion of the Site.

Main Conclusions of the Five-Year Review of 2018

The 2018 Five-Year Review stated the remedy for the Monsanto Site is **currently not protective** because:

- Concentrations of COCs in groundwater remain above MCLs and remedial goals (RGs),
- Contaminated groundwater plumes above the MCLs and RGs extend beyond the IC boundaries,
- The contamination in groundwater plumes has not been fully characterized which poses risks to domestic wells downgradient of the Monsanto Site,
- Monitoring trends indicate that the groundwater performance standards will not be met in the foreseeable future,
- Contaminated groundwater appears to be impacting surface water and sediment in nearby creeks,
- Sources on the Monsanto facility may be contributing to groundwater contamination.

Current Conceptual Site Model

The Conceptual Site Model (CSM) at the time of the 2007 ROD assumed that the closure and capping of suspected source areas in the 1980s was sufficient to stop additional loading of COCs in groundwater. Groundwater monitoring results indicate that concentrations of COCs have decreased at most monitoring locations. However, in some wells the downward trends have stabilized at concentrations above RGs, and at other locations the concentrations of COCs have been increasing near and downgradient of source areas.

The current CSM is that the following former facilities remain as ongoing source areas to the groundwater zone listed below:

- Old Under Flow Solids (UFS) Ponds (including the old Tailings Pond) to UBZ-2 and UBZ-4
- Old Hydroclarifier to UBZ-4
- Northwest Pond to UBZ-4

The current CSM is that the permeable material, including crushed slag, that currently covers the former Old UFS and Tailings Ponds allow rainfall and snow melt to infiltrate into the buried UFS/tailings, dissolve COC, and continually load the groundwater metals plume. See Figure 1 below. It is estimated that approximately 21,300 tons of UFS/tailings remain in the vicinity of the Old UFS Ponds and approximately 23,500 tons of UFS/tailings remain in the vicinity of the former Tailings Ponds. Leach testing of the UFS/

tailings material indicates that leaching can occur with concentrations of COCs in the leachate above RGs. The data show that, on average, COCs are leaching to concentrations 10 (for selenium) to 100 (for cadmium) times their respective RGs. Samples of the native soil underneath the Old UFS and Tailings Ponds have elevated concentration of COCs, likely from the downward migration of the leachate from the buried UFS/tailings material.

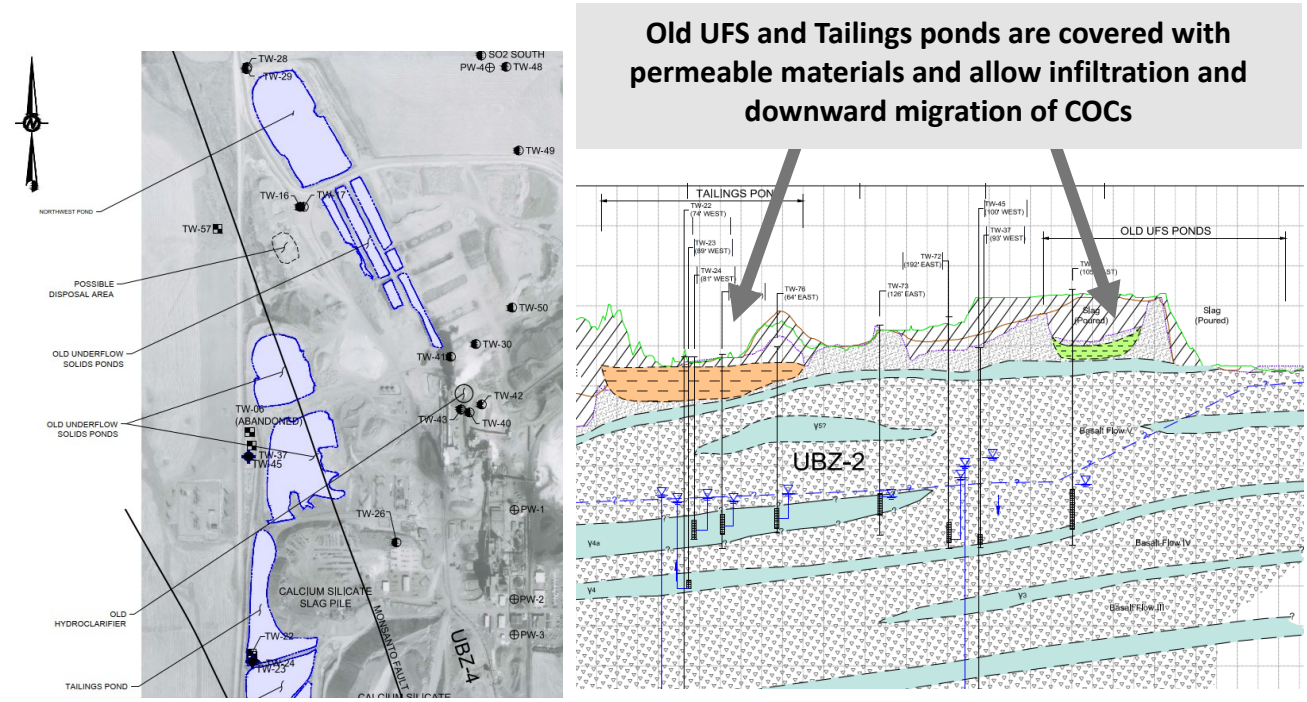

Figure 1. Location and Cross Section of the Old UFS and Tailings Ponds

Due to the very complex hydrogeology of the site, it is unclear which zones (UBZ, LBZ) is the deepest that has been impacted by the leaching from the Old UFS and Tailings Ponds. The gamma 4 groundwater zone is the most impacted. The extended pumping tests associated with the Demonstration Unit (pump and treat system) pilot study in the UBZ-1/UBZ-2 aquifers are focused on the gamma 4 groundwater zone. Some elevated COCs have be observed in the gamma 3 zone downgradient from the pumping wells. However, the selenium plume appears to be retracting in nearby wells. Although pumping at the fence line is a necessary interim measure, there appears to be sufficient UFS/tailings material remaining in place to provide an ongoing source for a long period of time. The long-term efficiency of groundwater capture and treatment has not been fully assessed or reported.

The CSM at the time of the 2007 ROD also assumed that the existing load of COCs would naturally attenuate to be below RG concentrations prior to reaching potential receptors downgradient of the Site. The current CSM is that some of the COCs, especially selenium, are much more mobile in groundwater at this Site than thought of in the 2007 ROD. No sequential extraction samples of the UFS/tailing and native soil have been analyzed. Therefore, the form(s) of leachable source material and the adsorptive capacity of the downgradient matrix minerals can only be estimated. There is no model of the capacity of these materials for natural attenuation. Although cadmium, for example, can be effectively attenuated by common adsorbents like iron oxides in the native soil, if the UFS/tailings source of cadmium is greater than the adsorptive capacity of the native soil, then eventually higher cadmium concentrations in groundwater will breakthrough when the adsorptive capacity of the native soil is reached. Without a demonstration with matrix property data and a model it is unclear how and if natural attenuation would occur.

Remedial Options for the Remaining Source Areas

The closure and capping of suspected source areas in the 1980s was assumed to have been successful. Therefore, operations of the facility have covered the suspected source areas with various materials, including parking areas, buildings, and very large piles of slag. Remedial options that could be included in an assessment of the feasibility to address remaining source areas could include:

- Cover with impermeable materials.
- Regrade areas to direct precipitation away from buried sources.
- Excavate buried tailings and consolidate into an appropriate repository.
- In-Situ treatment and stabilization.